

DESIGN CRITERIA AND SPECIFICATIONS

FOR

WATER MAINS AND APPURTENANCES

TULLAHOMA UTILITIES AUTHORITY

SPECIFICATIONS NO. TUA-W-287 REV. XI

DECEMBER 2017

FORWARD

It is intended that this design criteria and these specifications be used for the construction of potable water lines in the City of Tullahoma and surrounding areas served by the Tullahoma Utilities Authority.

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WATER DISTRIBUTION SYSTEM

DESIGN CRITERIA

SECTION I

I. SCOPE

The design criteria for water distribution systems presented hereinafter offer basic standards for use in the design process. Much of the information contained herein, as well as additional information may be obtained from the RULES OF TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION DIVISION OF WATER RESOURCES, CHAPTER 0400-45-01, PUBLIC WATER SYSTEMS, and the Division of Water Resources Community Public Water Systems Design Criteria.

II. ENGINEER'S REPORT

An engineer's report shall be written and submitted to the Tullahoma Utilities Authority (TUA). The engineer's report shall be submitted for review prior to the preparation of final plans. The engineer's report shall be submitted at least 30 days prior to the date on which action by TUA is desired. The engineer's report shall address all applicable points as set forth by these specifications.

III. DESIGN FACTORS

A. Source of Water Supply

The source of water supply for the distribution system under design shall be thoroughly investigated to ascertain that it can supply the average and peak daily demands imposed upon it by the proposed system without loss or burden to the existing customers supplied by it.

B. Water Consumption

In addition to fire flow requirements, water mains and distribution systems shall be sized for an instantaneous peak demand of 2 gallons per minute per connection.

C. Fire flow Requirements

A minimum fire flow of 500 gallons per minute at 20 pounds per square inch residual pressure must be available in all distribution systems containing fire hydrants. The requirements of the Insurance Services Office and related

agencies shall be investigated and complied with if more stringent than the minimum flow set forth above.

Water distribution system extensions designed to serve commercial, industrial, or institutional users shall be evaluated and sized to provide fire protection as required by the Insurance Services Office, and/or State and local responsible agencies on a case-by-case basis.

D. Minimum Size

The minimum size of water distribution mains shall be that which is required to provide the instantaneous peak demand plus fire flow while maintaining adequate residual pressure. The minimum size of pipe allowable by TUA is 8-inch diameter unless otherwise approved by TUA. In no case shall pipe smaller than 6-inch diameter be allowed where fire protection is required.

E. Sizing Water Mains

Water mains shall be sized to provide the instantaneous peak demand plus anticipated fire flow plus any foreseeable future demand while maintaining a minimum of 20 pounds per square inch residual pressure at all points in the system. The pressure losses due to friction must be calculated from the storage or pumping facilities using typical system flows as well as the flows required by the distribution mains being added. From this information, a hydraulic profile is plotted for submittal to TUA. The plotting shall show the water system hydraulic gradient in relationship to the ground line at all points for the planning extensions and any pertinent points in the existing system. If advantageous, loop analysis may be performed to reduce the losses. If loop analysis is used, a Hardy-Cross or other loop analysis program shall be used. Single path friction loss is readily available from many published tables and nomographs or it may be calculated from the Hazen-Williams equation:

$$h_f = 0.002083 L (100/C)^{1.85} \times (\text{gpm}^{1.85}/d^{4.8655})$$

This equation is based on water at 60 degrees F. and the symbols used are as follows:

- h_f = head loss due to friction, feet of water
- L = length of pipe, including equivalent length for losses through fittings, feet
- C = Roughness coefficient
- gpm = flow of water, gallons per minute
- d = inside diameter of circular pipe, inches

The C value varies widely, depending on type and age of pipe. For new pipe, the maximum value allowed by the TDEC-DWR is 130.

All calculations and the hydraulic profile shall be submitted to TUA for consideration during their review of the plans and specifications.

F. Dead-End Lines

Deadend lines are detrimental to water quality and fire flows, and shall be avoided where feasible. Loop and grid connections shall be used when possible.

Upon plans review by TUA, additional tie-ins, mains and grid connections may be required to enhance the performance of the water system.

G. Private Fire Connections

Private fire connections shall be constructed using Ductile Iron Pipe and appurtenances as specified in SECTION I, Chapter IV.

Where full registration metering devices are not provided, a Factory Mutual approved water flow double check detector assembly shall be provided to indicate water flow and ensure back flow prevention.

In all cases, backflow prevention protection equivalent to or exceeding a double check detector assembly shall be provided.

H. Services

Each property, platted lot, or planned facility location shall be provided a water service complete with all appurtenances, except meter, to the property line. Services shall be installed with the distribution system.

IV. SELECTION OF PRESSURE CLASS FOR WATER MAINS

A. Determination of Maximum and Minimum Pressures Within the System

In the determination of the proper pressure class of pipe materials for use in the system, consideration must be given to the maximum and minimum pressures that will be encountered. The following factors must be considered when determining pressure within a system:

1. Highest and lowest elevations of pipelines;
2. High and low levels in the water storage reservoirs;
3. Booster pumping stations - suction and discharge pressures;
4. Fire flow requirements;

5. Special control valves, i.e., pressure reducing valves in the system;
6. Surge allowance and water hammer; and
7. Customer water usage (present and future).

B. Ductile Iron Pipe

Ductile iron pipe is manufactured in seven (7) standard thickness classes, Class 50 through Class 56. The recommendations for thickness found in AWWA C-151 shall be followed. It is recommended that ductile iron pipe be used when the pipeline to be constructed is crucial to the supply of finished water to a distribution network or in highly urbanized areas where the cost for maintenance or replacement exceed the costs benefits realized from less expensive pipeline materials. In addition, all private fire connections shall utilize ductile iron pipe.

C. Polyvinyl Chloride Pipe

1. General

Polyvinyl chloride (PVC) pipe for installation in water distribution systems is manufactured under one of two standards: ASTM D-2241 or AWWA C-900.

2. ASTM D-2241 Pipe

PVC pipe manufactured under ASTM D-2241 is pressure rated for each Standard Dimension Ratio (SDR). The TDEC-DWR guidelines state that ASTM D-2241 pipe shall not be used where the working pressure will exceed 2/3 of its pressure rating. The remaining 1/3 is utilized as surge allowance. SDR 21 may be used where the working pressure will not exceed 133 psi and SDR 17 may be used where the working pressure will not exceed 167 psi.

3. AWWA D-900 Pipe

AWWA C-900 PVC pipe is pressure rated for each Dimension Ratio (DR). Due to its design, the full pressure rating can be utilized as working pressure. DR 14 is suitable for working pressures to 200 psi and DR 18 is suitable for working pressures to 150 psi.

V. LOCATION OF APPURTENANCES

A. Control Valves

Control valves (gate valves), at minimum, shall be placed at all intersections of water mains but at no time greater than 1500 feet apart within the City limits. Rural valves may be spaced up to 2500 feet apart.

B. Safety Valves

Safety valves (air release, pressure reducing, etc.) shall be installed at such locations as deemed necessary for the safe, reliable operation of the distribution system.

C. Fire Hydrants and Blow-Offs

In general, fire hydrants for residential areas shall be spaced at 600 feet or less and/or at street intersections, whichever is less; for commercial areas, at least 400 feet or less and/or street intersections, whichever is less; and for public and institutional properties, a number and spacing to accommodate the needed fire flows with adequate back-up spacing. The above spacings are measured as hose can be laid by apparatus. A fire hydrant shall be located at the end of each extension for both fire protection and line flushing. In systems where fire protection is not offered, blow-off hydrants shall be installed at the end of each line and at each location required to provide adequate flushing of the mains.

D. Thrust Blocking

Thrust forces are created in a pipeline at changes in direction, tees, dead-ends, or where changes in pipe size occur at reducers. Acceptable restraint methods include concrete thrust blocks, restrained joints and tie rods. The details and dimensional data for concrete thrust blocks given in Standard Drawing TBD 1 & 2 are for 100 pounds per square inch (psi) working pressure and soil bearing load of approximately 1000 pounds per square foot (psf). For greater pressure or less soil bearing, the quantities required will have to be recalculated, but for pressure less than 100 psi and soil bearing greater than 1000 psf, the thrust blocks shown shall be adequate.

E. Identification Tape and Detection Wire

A metalized tape shall be installed in the ditch above the pipe to allow location by a metal detecting device and to alert construction workers of the presence of a water line. The tape shall be color coded and labeled to identify the type of line. Tape shall be installed within one foot of finished grade and shall be at least six inches wide.

A 14 gauge insulated copper detection wire shall be installed at the trench bottom and stubbed up at each valve location and left accessible inside the valve box. The wire shall form a continuing loop in the water system. All splices in the wire shall be made securely and covered thoroughly with electrical tape.

VI. INSTALLATION AND ACCEPTANCE TESTING

As a minimum, the specifications shall require acceptance testing to include pressure and leakage testing. Detailed specifications for acceptance testing are stipulated in Section II of these specifications.

Pressure tests shall be performed at a pressure the greater of 150 psi. or 50% above the working pressure at the test point. Pressure shall be maintained for two (2) hours. The leakage test shall be conducted concurrently with the pressure test to check for excessive leakage.

All water pipe shall be cleaned and disinfected in accordance with Section II of these specifications.

VII. PREPARATION OF PLANS

A. General

Plans for water distribution mains must be submitted to TUA for review and approval. The plans must be prepared on 24" x 36" plan sheets and the four (4) sets submitted must be of quality suitable for reproduction. Each sheet of a set of plans must bear a signed and dated imprint of a professional engineer's seal.

B. Title Sheet

The title sheet for a set of plans generally contains the following: Name of project, name of municipality, area to be served, municipal officials' names, index of drawings, date, address, and names of the design engineer (in addition to seal).

C. General Layout Sheet

The general layout sheet shall include a large scale map of the entire distribution system showing the corporate or utility district boundaries. Existing and planned utilities shall be shown with line sizes noted and easily distinguishable between existing and planned. The layout sheet shall incorporate both a north arrow and scale and if the area to be served is obscure, a location plan shall be provided showing the municipality or utility district in relation to surrounding towns, streams, and noted landmarks.

D. Plan Sheet

The plan sheets shall be drawn at a scale of 1 inch equal to 50 feet, or other scale approved by TUA, and be complete with north arrow, scale, street and road

names, existing utilities, planned utilities, and installation notes with locations shown for all valves, hydrants, and other appurtenances. The plan sheets shall also provide adequate descriptions of any features not otherwise covered by the specifications. The planned water distribution mains shall have adequate notes and stationing system to aid in the location of the water lines and appurtenances.

E. Detail Sheets

Any feature of construction which requires additional clarification to that shown on the plan sheets shall be drawn in detail on the detail sheets. Each detail shall cover thoroughly the dimensions, equipment, materials, method of construction, and any clarifying notes to aid in construction of the item.

F. As-Constructed Drawings

Following the end of construction of the water distribution mains, the drawings shall be revised to reflect any deviations from the plans and provide the precise field location of the water mains, valves, hydrants, services, and other appurtenances. An electronic copy compatible with TUA's CAD system, and one paper copy of the As-Constructed drawings shall be submitted by the engineer to TUA while the engineer shall keep the drawings available for future reference and additional prints, if required.

WATER DISTRIBUTION SYSTEM

CONSTRUCTION ITEMS

SECTION II

WATER MAINS, LATERALS, FITTINGS, VALVES, VALVE BOXES, FIRE HYDRANTS, AND SERVICES, INCLUDING METERS

I. GENERAL

A. Scope

Work performed under this Section of the specifications shall include the furnishing of all labor, tools, equipment, and materials; the performance of all work necessary to install water distribution mains, laterals, fittings, valves, fire hydrants, and appurtenances; and the installation of pipe by the jacking and boring method, all complete and ready for use.

Work performed under this Section of the specifications shall conform to the applicable requirements of “American National/AWWA Standard for Installation of Ductile-Iron Water Mains and Appurtenances”, ANSI/AWWA C600 of latest revision, unless specifically modified by these specifications.

B. Location of Mains and Appurtenances

1. The general location of water mains, laterals, and appurtenances is indicated on the plans of the various streets.
2. Where the locations of water mains, laterals, and appurtenances are shown on the plans referred to street center-line or base lines, these locations shall be rigidly adhered to.
3. Valves on water distribution shall be located within the street right-of-way unless detailed location is shown otherwise on the plans.
4. Fire hydrants shall be set at locations shown on the plans or as directed by TUA. Fire hydrants shall be set in such a position that all nozzles and operating nuts are fully accessible and have adequate clearance from any obstacle. Locations shall be chosen which will provide protection from damage from vehicular traffic and interfere as little as possible with pedestrian traffic.

II. PRODUCTS

A. Polyvinyl Chloride (PVC) Pipe

1. All plastic pressure pipe shall be made from Class 12454-B polyvinyl plastic PVC 1120) as defined by ASTM D1784.
2. All PVC pipe shall be Class 200 (SDR 21), Class 250 (SDR 17), or Class 315 (SDR 13.5) pipe, as indicated on the drawings. All PVC pipe shall have NSF approval and be manufactured in accordance with ASTM D2241, except that the following tests shall be run at least once each hour per machine on each size and type of pipe being produced.
 - a. Flattening Test: A specimen at least 2” long shall be flattened between moving parallel plats in a suitable press until the opposite inside surface touch and 100% flattening has occurred. The rate of loading shall be uniform and such that the compression (100% flattening) is complete within 2 to 3 minutes. Upon completion of the test, the specimen shall not be split, cracked, or broken.
 - b. Extrusion Quality Test: The method of testing shall be in accordance with ASTM D2152. There shall be no flaking, peeling, cracking, or visible deterioration on the inside or outside surface after completion of the tests.
 - c. Quick Burst Test: This test shall be performed in accordance with ASTM D1599. The PVC pipe specimen shall be pressurized to burst between 60 and 70 seconds. The burst pressure must exceed the minimum burst pressure requirements given below:

<u>SDR</u>	<u>Pressure Rating</u>	<u>Minimum Bursting Pressure, psi</u>
13.5	315	1,200
17	250	1,000
21	200	800
 - d. Impact Test: All SDR 13.5 to 21 (315 to 200 pound pressure rated) pipe shall be tested. The manufacturer shall also provide results of impact tests conducted.
3. If any specimen fails to meet any of the above mentioned tests, all pipe of that size and type manufactured between the test periods must be scrapped.
4. The pipe manufacturer shall furnish a certificate stating that he is fully competent to manufacture PVC pipe of uniform texture and strength and in full compliance with these specifications and further stating that he has manufactured such pipe and done so in sufficient quantities to be certain that it will meet all normal field conditions. In addition, the manufacturer’s

equipment and quality control facilities must be ensure that each extrusion of pipe is uniform in texture, dimensions, and strength. The manufacturer shall also certify that the pipe furnished for this project meets the requirements of these specifications.

5. All pipe shall be manufactured in the United States of America. All pipe for any one project shall be made by the same manufacturer.
6. All 6" and larger pipe shall be furnished in 20' lengths. The storing and handling of the pipe shall be done in a manner acceptable to TUA. All pipe shall be supported within 5' of each end; in between the end supports, there shall be another additional support. The pipe shall be stored away from heat or direct sunlight. The practice of stringing pipe out along the proposed water line routes will not be allowed.
7. Certain information shall be applied to each piece of pipe. At the least, this shall consist of:
 - a. Nominal size
 - b. Type of material
 - c. SDR or class
 - d. Manufacturer
 - e. NSF Seal of Approval
8. Pipe that fails to comply with the requirements set forth in these specifications shall be rejected.
9. The pipe shall have push-on joints designed with grooves in which continuous molded rubber ring gaskets can be placed and shall conform to ASTM D3139. Gaskets shall be made of vulcanized natural or synthetic rubber; no reclaimed rubber will be allowed. The gaskets shall be of the manufacturer's standard design dimensions and of such size and shape as to provide a positive seal under all combinations of joint and gasket tolerance. The gasket and annular groove shall be designed and shaped to that when the joint is assembled, the gasket will be radically compressed to the pipe and locked in place against displacement, thus forming a positive seal.
10. The spigot end of each pipe shall be beveled so that it can be easily inserted into the gasket joint, which in turn shall be designed so that the spigot end may move in the socket as the pipe expands or contracts. The spigot end shall be striped to indicate the distance into which it should be inserted into the socket. Each joint shall be able to accommodate the thermal expansions and contractions experienced with a temperature shift of at least 75 degrees F.

11. Enough lubricant shall be furnished with each order to provide a coat on the spigot end of each pipe. This lubricant shall be non-toxic, impart no taste or smell to the water, have no harmful effect on the gasket or pipe material, and support no bacterial growth. The lubricant containers shall be labeled with the manufacturer's name.
12. Joints shall be either integral bell and ring joints with rubber compression gaskets as manufactured by the Clow Corporation, twin gasket couplings as manufactured by the Certain-Teed-Products Corporation, gaskets as manufactured by John-Manville, or equal. However, the pipe and bell must be made by the same manufacturer.

B. Ductile Iron (DI) Pipe

1. All DI pressure pipe will be manufactured in accordance with ANSI A-21.50 (AWWA C-151) and ANSI A-21.10 (AWWA C-100).
2. All DI pipe shall have a standard cement lining meeting the requirements of ANSI 21.4 (AWWA C-104).
3. A minimum of 1 mil thick bituminous coating shall be on the outside surface of all DI pipe.
4. Pipe shall be clearly marked with manufacturer's name, D.I. or ductile, weight, class or nominal thickness, and casting period.
5. Unless otherwise specified or shown on the plans, DI pipe shall be thickness Class 52.
6. Joints shall be either push-on or mechanical joint configuration.

C. Ductile Iron Fittings

1. Fittings: Ductile iron fittings shall conform to the requirements of the American Standard Specifications, ANSI A21.10/AWWA C110, Ductile-iron and Gray-iron Fittings, 3-inch through 48-inch for Water and Other Liquids, latest revision. Standard mechanical joint fittings shall be used. The gaskets shall be the proper kind for attachment with the type of pipe being used.
2. Coatings and Linings: All ductile iron fittings shall be given an outside bituminous coating, as stipulated in the ANSI specifications referred to above. Fittings shall be lined with Enameline or a thin cement lining in accordance with American National Standard ANSI A21.4/AWWA C104, latest revision. In addition, a bituminous seal coat or asphalt emulsion

spray coat approximately 1 mil thick shall be applied to the cement lining accordance with the pipe manufacturer's standard practices.

D. Valves and Accessories

1. Resilient Seat Gate Valves:

- a. Resilient seat gate valves shall have a full opening equal to the size of the pipe on which they are installed and shall open by turning counterclockwise.
- b. Resilient seat gate valves shall be iron body, machined surface, modified wedge disc, resilient rubber seat type valves. Resilient seat gate valves shall have the bronze stem nut cast integrally with the cast iron valve disc. The valve shall have machined seating surface and capable of being installed and operated in either direction. Valves shall be furnished with mechanical joint ends in accordance with USA Standard A21.11 unless otherwise shown or directed.
- c. All valves installed below ground shall be non-rising stem type with two-inch square operating nut, marked to indicate the direction of opening. All underground valves which have nuts deeper than 30 inches below the valve box top shall have extended stems with nuts located within one foot of the valve box cap. All valves installed above ground shall be outside stem and yoke (OS&Y) type equipped with hand wheel for manual operation, marked to indicate the direction of opening.
- d. Valves shall be for working pressure up to 200 psi and shall be equal to latest specifications of AWWA C509 in all respects.
- e. Valves shall be suitable for installation in the vertical position in buried pipe lines. Stem shall consist of O-ring seals. Valves shall be manufactured by Mueller or equal.

2. Cutting-In Sleeve and Valves:

Cutting-In sleeve shall be Mueller H-840, M & H or approved equal, and the gate valves shall be Mueller H-862, M & H, or approved equal.

3. Tapping Sleeve and Valves:

Tapping sleeves and valves shall consist of Mueller H-304 stainless steel tapping sleeve, or approved equal, and Mueller T-2360 or M & H tapping valve, or approved equal.

E. Valve Box Frames and Covers

Valve Box frames and covers shall be made of cast iron and shall meet the requirements of ASTM A-48, Class 30.

All castings shall be made accurately to the required dimensions and shall be sound, smooth, clear and free of blemishes or other defects. Defective castings which have been plugged or otherwise treated to remedy defects shall be rejected. Contact surfaces of frames and covers shall be machined so that the covers rest securely in the frames with no rocking or movement. The cover shall be in contact with the frame for the entire perimeter of the contact surface.

The valve box frames and covers shall be as manufactured by John Bouchard and Sons Company, Nashville, Tennessee, No. 8004 Roadway Type, or approved equal. The cover shall be marked "WATER".

A minimum 2-foot square concrete collar shall be placed around the top of the valve box in non-paved areas to provide support of the box. The collar shall be a minimum of 4-inches thick and sloped to drain away from the box. If there is an annular space between the collar and the valve box it must be grouted.

F. Fire Hydrants

Fire hydrants shall be three-way, cast iron body, of the dry head, breakable traffic type with breakable safety flange at the ground line, shall have a working pressure of 250 pounds per square inch, and shall meet AWWA C502 Specifications for Fire Hydrants, of latest revision.

Threads on nozzles and operating nut, and direction of operation shall match existing hydrants in the City of Tullahoma. The main valve of the hydrant shall have a full opening of at least five and one-fourth inches (5-1/4") and the hydrant drain shall operate with the main valve. Fire hydrants shall have a 42-inch bury, bronze to bronze seating, a penta operating nut with one and one-half inch (1-1/2") point to flat and a mechanical joint shoe that incorporates a check valve located inside the hydrant inlet, allowing normal operation and access to the hydrant valve through the bonnet or ground flange. The check valve shall have a fabric and steel reinforced elastomeric flapper and be designed for full flow.

An integral four-inch Storz connector with a Knox® Storzguard cap shall replace the pumper nozzle.

Fire hydrants shall be Mueller® Super Centurion 250/HS High Security Model A-423 and shall be yellow in color.

G. Services

1. Main Connections: All tapping of mains shall be done in the upper half of the pipe and approximately at a 45° angle from the vertical. Tapping saddles shall be used for all taps on PVC pipe.
2. Materials for Service Connections: All corporation cocks, fittings, and curb cocks shall be made of brass. The following items shall be as hereinafter described:
 - a. Corporation stop with Mueller thread inlet and compression outlet -- Ford, Mueller, or equal.
 - b. Tapping saddles, bronze.
 - c. Meter yoke, 5/8" x 3/4" - Ford 70 Series Coppersetter VB72-7W-41-33 or approved equal.
 - d. Meter yoke, 1" – Ford 70 Series Coppersetter VB74-10W-41-44 or approved equal.
 - e. Meter yoke, 2" – with bypass, Ford Coppersetter VBB77-15B-11-77 or approved equal.
3. Crosslinked Polyethylene (PEX) Water Service Tubing: Service line tubing shall be Rehau Municipex® crosslinked polyethylene (PEX) tubing, or approved equal. The tubing must meet or exceed the requirements of ASTM F876, F877, CSA B137.5 and PPI TR-3, and be certified to NSF Standards 14/61 and AWWA C904. The tubing shall meet the requirements of ASTM F2023 for chlorine resistance.

The tubing shall be produced in SDR 9 copper tube sizes allowing it to connect to standard compression-joint brass valves and fittings using inserts (required) per the recommendation of the fitting manufacturer.

H. Water Meters

1. All water meters of sizes 5/8"x3/4", 3/4", and 1" shall conform to the following specifications:
 - a. General: All meters shall conform to AWWA C700, Standard for Cold-Water Meters -- Displacement Type, of latest revision. All water meters of this size shall be manufactured by Hersey and be compatible with the Mueller Mi.Net AMI system.
 - b. Registers: The registers shall be of the double or hermetically sealed, direct reading type registering in gallons and shall be equipped with a

center sweep hand. The engineer is to coordinate the type of registration with TUA if meters are to be supplied with development.

- c. Capacity, Accuracy, and Test Certification: Capacity, accuracy, and test certification shall comply with AWWA C700.
- d. Guarantee: Each meter shall be guaranteed for a period of one year from date of installation as per section 21 of AWWA C700. Registers shall be guaranteed for a period of ten years.
- e. Connections: The 5/8" meter will have 3/4" meter yokes and shall be referred to as 5/8" x 3/4" meters.

2. All water meters of sizes 1-1/2", 2", 3", 4" and 6" shall conform to the following specifications:

General: All meter packages shall meet or exceed requirements of ANSI/AWWA Standard C702 for class II compound meter assemblies. All meters of this size shall be Sensus OMNI™ C². An integral strainer must be included. The meter shall read in U.S. gallons.

Electronic Registers: The meter's register shall be all-electronic and contain no mechanical gearing. The electronic register shall include the following partial list of features: AMR resolutions units fully programmable, Pulse output frequency fully programmable, Integral data logging capability, Integral resettable accuracy testing feature, LCD display, and 10 year battery life.

- I. Meter Boxes: Meter boxes shall be high-density polyethylene of one-piece molded construction and shall have a wall thickness of no less than 0.550 inches. The meter box, with a polyethylene cover installed shall be able to bear a 20,000 lb load in a wheel load (H-20) style test, and able to withstand a 200 lb side load. The exterior of the meter box shall be black to prevent UV degradation, and bright white on the interior to reflect light and ease meter reading and service. The box shall be designed in such a way as to have an integral flange, no more than 3 inches from the top, to support the box in concrete, paving and soil, and bottom flange a minimum of 1 inch wide to help retard settling. The box shall have removable pre-cut entry areas, 3" wide x 4" high, located on the center of each end of the box. The box shall be designed in such a way as to be securely stackable, and shall be available in 18 inch heights. The meter box shall be model MSBCF-XL as manufactured by Mid-States Plastics Inc. or approved equal.

- J. Identification Tape and Detection Wire

The identification tape shall be metalized to allow location by a metal detecting device. The tape shall be color coded and labeled to identify the line as a water line. Tape shall be at least six inches wide and shall be as manufactured by Alarmtape, Allen Systems, or an equal approved by TUA. Detection wire shall be a 14 gauge insulated copper wire commonly called "bell wire".

III EXECUTION

A. Inspection of Materials:

A careful field inspection shall be made of all material before installation, and any material found to be damaged in shipment or not meeting the requirements of the specifications will be rejected and replaced.

B. Alignment and Grade:

1. All pipe shall be laid and maintained to the required lines and grades. Fittings, valves, and hydrants shall be at the required locations and with joints centered, spigots home, and all valves and hydrant stems plumb.
2. Temporary support and adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the contractor.
3. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the contractor in cooperation with owners of such utility structures.
4. All pipe shall be laid to the depth shown on the contract drawings or as required by the Engineer in writing. The depth shall be measured from the established street grade or the surface of the permanent improvement to the top of the pipe barrel. This depth of cover shall not be less than thirty inches (30").

C. Excavation of Trench

1. The trench shall be dug to the required alignment and depth shown on the contract drawings and/or as specified above only so far in advance of pipe laying as TUA shall permit. The trench shall be braced and drained when necessary so that workmen may work therein safely and efficiently.
2. The trench width at the ground surface may vary with, and depend upon, its depth and the nature of the ground encountered. The minimum clear width of unshheeted or sheeted trench measured at the horizontal diameter of the pipe shall be 18 inches, or one foot greater than the outside diameter of the barrel of the pipe, whichever is greater. The maximum clear width of trench at the top of the pipe shall be not more than the outside diameter of the barrel of the pipe plus two feet.
3. The pipe shall be laid on firm soil, cut true and even to afford bearing for the full length of the barrel of the pipe, or on earth mounds.

4. Any part of the trench excavated below grade shall be corrected with thoroughly compacted material approved by TUA.
5. When an unstable sub-grade condition is encountered, an additional depth shall be excavated and refilled to pipe foundation grade with crushed stone or other suitable material as required to achieve a satisfactory trench bottom.
6. Ledge rock, boulders, and large stones shall be removed to provide clearance to each side of, and below, all pipe and accessories. This clearance for pipe and accessories shall be six inches.
7. Excavations below sub-grade in rock or in boulders shall be refilled to sub-grade with material approved and thoroughly compacted.
8. Wherever necessary to prevent caving, trench excavations in soils such as sand, gravel, and sandy soil shall be adequately sheeted and braced. Where sheeting and bracing are used, the trench width shall not be less than that specified above. As backfill is placed, if sheeting is to be withdrawn, it shall be withdrawn in increments not to exceed one foot, and the void left by the withdraw sheeting shall be filled and compacted.
9. All excavated materials shall be piled in a manner that will not endanger the work and will avoid obstructing sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street drainage.
10. The use of trench-digging machinery will be permitted except where its operations will cause damage to trees, buildings, or existing structures above or below the ground. At such locations, methods by hand shall be employed to avoid such damage.
11. To protect persons from injury and to avoid property damage, adequate barricades, construction signs, torches, warning lights and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for traffic use. Whenever required, watchmen shall be provided to prevent accidents. Rules and regulations of the local authorities regarding safety provisions shall be observed.
12. Excavations for pipe laying operations shall be conducted to cause the least interruption to traffic: Hydrants under pressure, valve-pit covers, valve boxes, curb-stop boxes, fire or police call boxes, or other utility controls shall be unobstructed and accessible during the construction period.

13. Adequate provisions shall be made for the flow in sewers, drains, and water courses encountered during construction. The structures which may have been disturbed shall be satisfactorily restored.

D. Preparation of Trench Bottom:

1. Pipe shall be laid directly on a trench bottom containing coupling holes so as to provide a continuous contact with the pipe between coupling holes.
2. Coupling Holes: Prior to lowering pipe into the trench, a coupling hole shall be dug in the trench bottom having a length, width, and depth to allow assembly and to maintain a minimum clearance of two inches (2") between coupling and undisturbed trench bottom.
3. Shaping Trench Bottom: Prior to lowering pipe into the trench, the trench bottom between coupling holes shall be made flat and cut true and even to grade so as to provide continuous contact of the trench bottom with the pipe.
4. Crushed stone will be required, at TUA's discretion, as bedding and above the pipe in areas where rocky soils exist. This does not preclude the requirement for proper excavation of trenches.

E. Lowering Pipe and Accessories into Trench:

1. All pipe, fittings, valves, hydrants, and accessories shall be carefully lowered into the trench using suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
2. The pipe and accessories shall be inspected for defects prior to lowering into trench. Any defective, damaged, or unsound material shall be repaired or replaced.
3. All foreign matter or dirt shall be removed from the interior of pipe before lowering into position in the trench. Pipe shall be kept clean.

F. Installation of Pipe:

1. The interiors of pipes, fittings and valves shall be protected from contamination. The pipe delivered for construction shall be strung so as to minimize the entrance of foreign material. If dirt enters the pipe, it shall be removed and the interior pipe surface swabbed with a 1 or 5 percent hypochlorite solution. The new water main must be isolated from the active water distribution system until bacteriological tests are satisfactorily completed.

2. After a length of pipe has been placed in the trench with the spigot end forced home in the bell of the adjacent pipe, it shall be brought to the correct line and grade, and secured in place by tamping an approved backfill material around it.
3. Whenever pipe-laying is not in progress, the open ends of pipe shall be closed either with a watertight plug or by other approved means. If there is water in a trench, this seal shall be left in place until the trench has been pumped completely dry.
4. The pipe shall be cut so that valves, fittings, or closure pieces can be inserted in a neat and workmanlike manner and without any damage to the pipe. The manufacturer's recommendation shall be followed concerning how to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipe's axis.
5. Properly restrained bends shall be used for all major alignment changes. Joint deflections shall only be used for minor alignment changes necessary to avoid obstructions. Long radius curves by joint deflection shall only be used if approved by the TUA. In any event, joint deflectors shall not exceed manufacturer's recommendations, or that necessary for the joint to be satisfactorily made.
6. No pipe shall be laid in water or when trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, its use is considered incidental to the project, and no separate payment will be made for its use.
7. Where a water line crosses over a sanitary sewer, a full length of pipe shall be used with its joints straddling the sewer. Where a water line is to be parallel to a sanitary or storm sewer, it shall be laid at least 10' from the sewer. If it is not practical for the water and sewer lines to be separated as described above, the water line shall be laid at least 18" above the top of the sewer.
8. All pipe shall be joined in the exact manner specified by the manufacturer of the pipe and jointing materials.

G. Installing Pipe by Jacking and Boring Method:

Where water mains and laterals (except service lines) are to be installed in paved streets, roadways, sidewalks, etc., and it is undesirable to install pipe under this surface by means of an open cut trench, the contractor will install this pipe by jacking and boring.

H. Installing Identification Tape and Detection Wire:

A metalized identification tape shall be installed over the pipe and within one foot of finished grade.

A detection wire shall be installed with the pipe at the trench bottom. Wire shall be stubbed up at each valve location and left accessible inside the valve box. The wire shall form a continuous loop in the water system.

I. Thrust Blocks:

All reducers, caps, tees, eighth bends or greater, and such parts of the pipe work that will have a tendency to draw away or separate, shall be secured firmly by concrete thrust blocks poured as detailed on the plans or as directed by TUA.

J. Blow-Offs on Dead End Lines:

The contractor shall install a two-inch (2") blow-off on the end of each dead end line, except where fire hydrants are installed, to facilitate filling, sterilizing, and blowing-off of lines, both during construction and system operation.

K. Setting Hydrants:

1. Hydrants shall be lowered into the trench, inspected, cleaned and connected to pipe, and reaction or thrust blocks provided as specified herein for installation of water mains, laterals and fittings.
2. Each hydrant shall be connected to the main with a six-inch (6") pipe branch controlled by an independent six-inch (6") gate valve. Lengths of pipe and use of couplings between main and valve and hydrant shall be as shown on the drawings.
3. Whenever hydrants are set in soil classified as impervious, a drainage pit two feet in diameter and two feet deep shall be excavated below each hydrant. The pit shall be filled compactly with coarse gravel or broken stone mixed with coarse sand, under and around the bowl of the hydrant to a level six inches (6") above the waste opening. No hydrant drainage pit shall be connected to a sewer.
4. A reaction or thrust backing shall be provided at the bowl of each hydrant and shall be so placed as not to obstruct the drainage outlet of the hydrant, or the bowl of the hydrant shall be tied to the pipe main with rods.
5. Hydrants shall be thoroughly cleaned of dirt or other foreign matter before setting.

6. Hydrants shall be painted after installation with industrial quality paint. The barrel of the hydrant will be recoated with yellow paint and the bonnet color will be coated with a color specified by TUA.

L. Disinfection Procedures for New Water Mains

Calcium hypochlorite (HTH) granules that have been certified by the National Sanitation Foundation shall be used to disinfect newly installed water lines. The HTH granules shall be placed at the upstream end of the first section of pipe, at the upstream end of each branch main, at fire hydrant laterals and at 500 foot intervals of the new water system. The information in the table shown below lists the proper quantity of HTH for varying sizes of water mains.

<u>Pipe Diameter (in.)</u>	<u>Amount of Calcium Hypochlorite Granules (oz.)</u>
4	1.7
6	3.8
8	6.7
12	10.5
14 and larger	$D^2 \times 15.1$

(D is the inside diameter in feet)

TUA's water disinfection procedures that have been approved by TDEC DWR shall be used in cases in which water lines have been cut into whether by accident or design. TUA shall be made aware of any incidence of this type. The proper paperwork to record the disinfection procedures used shall be completed and filed by TUA.

M. Filling New Water Mains:

1. When the installation has been completed, the new water mains shall be filled so that the water in the mains has a velocity no greater than 1.0 ft/sec. The valves shall be manipulated so the highly chlorinated water will not flow back into the line that is supplying the water. Only TUA employees are allowed to operate the valves used to fill the new mains.
2. All air pockets must be eliminated. If fire hydrants or blow-off hydrants are not available at high points in the mains, the pipe shall be tapped at high points to vent the air.
3. The chlorinated water shall be retained in the lines for at least 24 hours, during which time all valves and hydrants in the line being treated shall be operated so that appurtenances can also be disinfected. After 24 hours, the treated water shall have a detectable free chlorine residual throughout the system.

4. After the applicable retention period, heavily chlorinated water should not remain in prolonged contact with the pipe. If there is high chlorine residual in the water, the water mains and laterals shall be flushed until the chlorine residual level in the new lines is no higher than the level normally found in the water distribution system.

N. Testing Water Distribution System:

1. The contractor shall provide all necessary equipment, gauges, labor tools, and services, and shall perform all work required in connection with testing water mains, laterals, and service lines. A representative of TUA must be present to witness the tests.
2. The contractor shall perform all pressure and leakage tests before backfilling the trenches.

a. Pressure Test:

- i. Before TUA shall accept any water lines, these lines or each valved section shall be tested at a hydrostatic pressure of at least 150 pounds per square inch. In low areas of the system where the working pressure plus 50 percent (50%) of this working pressure exceed 150 pounds per square inch, the lines (in the low areas) shall be tested at the working pressure plus 50 percent (50%) of this working pressure.
- ii. The duration of each pressure test shall be at least one hour.
- iii. The specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) shall be applied with a pump connected to the pipe.
- iv. All exposed pipes, fittings, valves, and hydrants shall be carefully examined during the test. Any cracked or defective pipes, fittings, valves, or hydrants discovered in consequences of this pressure test shall be removed and replaced with sound material in the manner specified. Repeat the test until the results are satisfactory.

b. Leakage Test:

- i. The leakage test shall be conducted after the pressure test has been satisfactorily completed.
- ii. The duration of each leakage test shall be 2 hours.

- iii. During the test, the main shall be subjected to a pressure of 150 pounds per square inch.
- iv. Leakage is defined as the amount of water which must be supplied to the newly laid pipe or any valved section in order to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
- v. No pipe installation will be accepted until the leakage per 2-hour period is less than the number of gallons listed below:

Pipe Sizes	Gallons per 1,000 Feet of Pipe
2-1/4" and smaller	0.2
3"	0.5
4"	0.6
6"	0.9
8"	1.2
10"	1.5
12"	1.9
14"	2.2
16"	2.6
18"	2.9
20"	3.2
24"	3.8

- vi. For pressures exceeding the minimum of 150 pounds per square inch during the test period, the allowable leakage shall be based upon the following formula:

$$L = \frac{ND\sqrt{P}}{7400}$$

Where L = allowable leakage in gallons per hour

N = number of joints in length of pipe line tested

D = nominal diameter of pipe in inches

P = average test pressure during the leakage test in pounds per square inch.

- vii. Should any test of pipe laid disclose leakage greater than that specified, the defective joints shall be located and repaired until the leakage is within the specified allowance.

3. If water mains have previously been tested and the water system has not been utilized for a period of time to be specified by TUA, TUA, at its discretion, may require the contractor to retest the system.

O. Bacteriological Tests:

1. After a potable water line has undergone final flushing, following the disinfection but before it is placed into service, two consecutive sets of acceptable samples, taken 24 hours apart, shall be collected for bacteriological testing for every 1200 feet of pipe and at the end of each water main and lateral (not including fire hydrant laterals). All samples must pass the bacteriological testing before the lines are put into service
2. The samples will be collected by TUA personnel and taken to the DRUC laboratory to be tested for bacteriological quality in order to determine if they contain any bacteriological organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples are obtained.
3. When the samples tested are found to be satisfactory, the water lines may be placed in service.
4. If water mains have previously been sampled and passed bacteriological testing but the water system has not been utilized for a period of time to be specified by the Tullahoma Utilities, new bacteriological samples will be collected and tested. If the samples fail to pass the bacteriological testing TUA, at its discretion, may require the contractor to re-disinfect the water mains.

P. Backfilling Trenches:

Backfilling of trenches shall be performed in accordance with ANSI/AWWA C600, latest revision. All materials used for backfill must be approved by TUA.

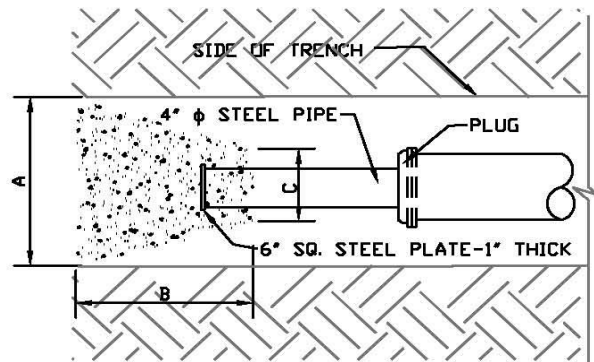
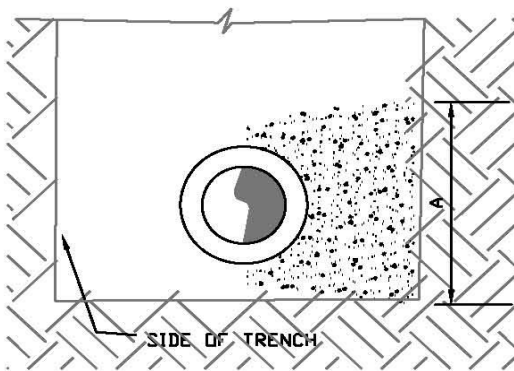
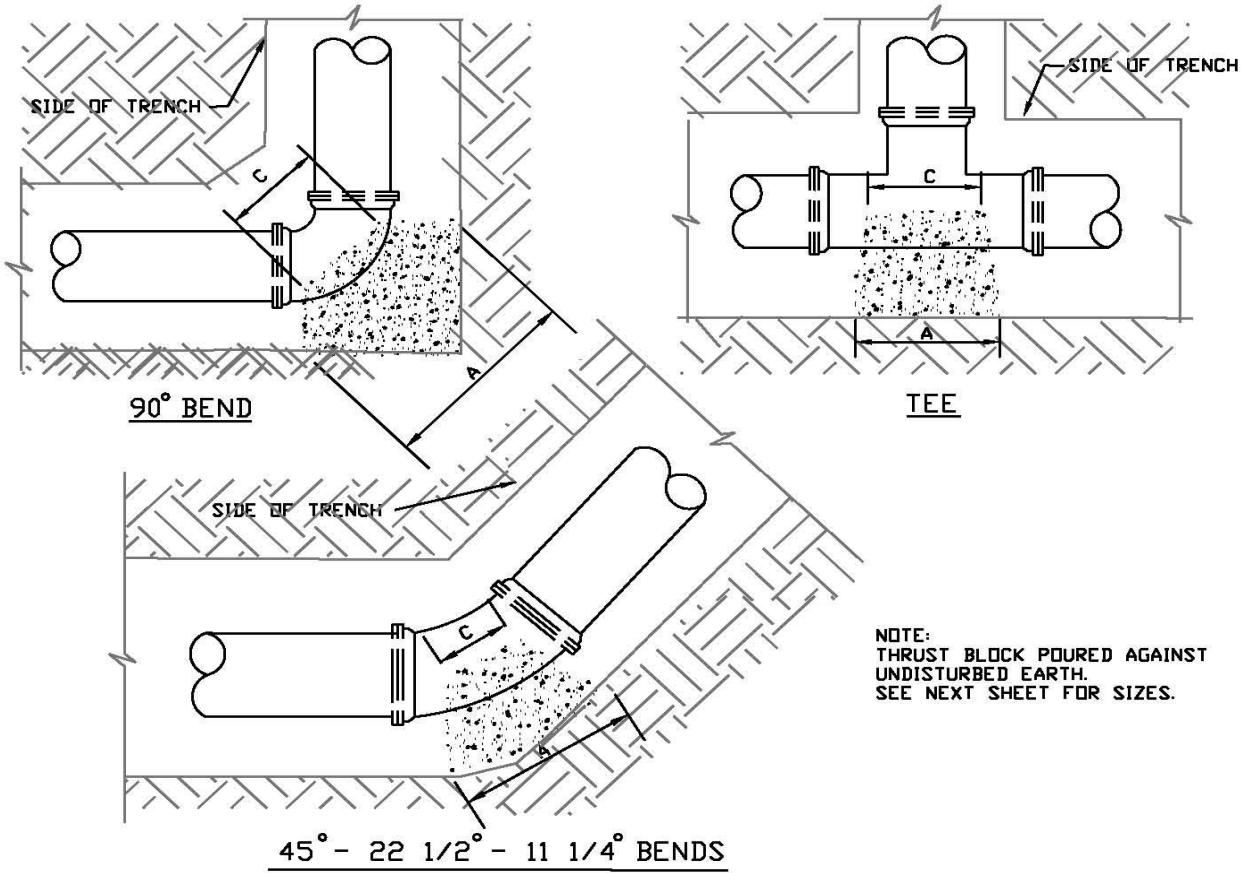
Q. Cleaning Up:

All excess excavated material, rubbish, and debris from adjacent street surfaces, gutters, sidewalks, parking areas, grass plots, etc., shall be removed and the project as a whole shall be left in a neat and acceptable condition.

R. Backfill and Repair of Street Cuts:

All cuts made in streets or other roadways shall be backfilled and repaired in a manner that meets all applicable local, State and/or Federal requirements.

IV. WATER DISTRIBUTION SYSTEM STANDARD DRAWINGS



TULLAHOMA UTILITIES BOARD

THRUST BLOCKING DETAILS TBD1

DRAWN BY: M.K.E..

DATE: 10-20-2009

NOT TO SCALE

90° Bend							
SIZE	2"	4"	6"	8"	10"	12"	18"
A	16"	16"	26"	33"	40"	50"	70"
B	16"	16"	24"	33"	40"	50"	70"
C	9"	9"	12"	12"	15"	16"	22"
D	8"	8"	12"	16"	20"	24"	24"

45° Bend							
SIZE	2"	4"	6"	8"	10"	12"	18"
A	12"	12"	18"	24"	31"	37"	52"
B	12"	12"	18"	24"	31"	37"	52"
C	8"	8"	10"	12"	14"	16"	16"
D	6"	6"	9"	12"	15"	18"	18"

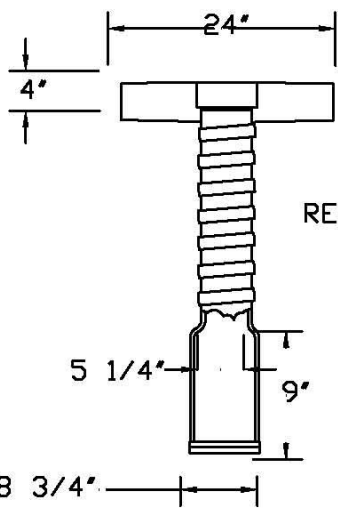
22 1/2° Bend							
SIZE	2"	4"	6"	8"	10"	12"	18"
A	9"	9"	13"	18"	23"	26"	40"
B	9"	9"	13"	18"	23"	26"	40"
C	8"	8"	10"	12"	14"	16"	16"
D	4"	4"	6"	9"	11"	13"	16"

11 1/4° Bend							
SIZE	2"	4"	6"	8"	10"	12"	18"
A	9"	9"	11"	13"	16"	18"	30"
B	9"	9"	11"	13"	16"	18"	30"
C	8"	8"	10"	12"	14"	16"	15"
D	4"	4"	5"	6"	8"	9"	16"

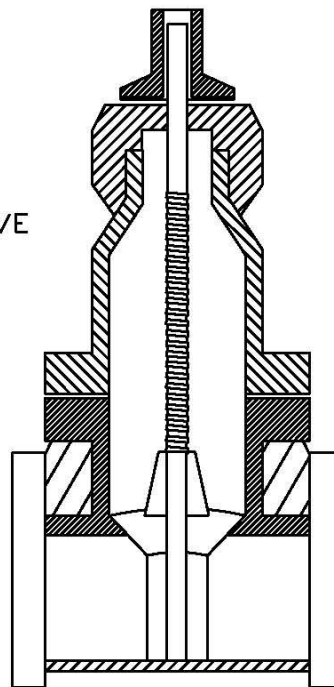
TEE								
SIZE	MAIN	2"-6"	8"-12"	3"-10"	12"	12"	12"	18"
	BRANCH	2"-6"	2"-6"	3"-10"	2"-6"	8"-10"	12"	16"-18"
A		26"	26"	43"	26"	43"	52"	70"
B		26"	26"	43"	26"	43"	52"	70"
C		12"	12"	12"	12"	12"	12"	30"
D		13"	13"	21"	13"	21"	26"	24"

PLUG							
SIZE	2"	4"	6"	8"	10"	12"	18"
A	26"	26"	26"	34"	43"	52"	70"
B	26"	26"	26"	34"	43"	52"	70"
C	12"	12"	12"	12"	12"	12"	30"
D	11"	11"	11"	15"	22"	32"	32"

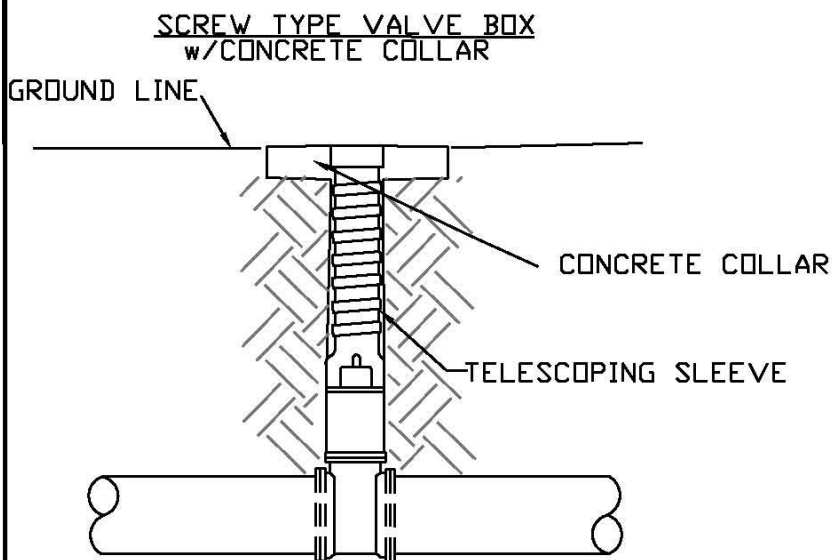
THRUST BLOCKING DIMENSIONS



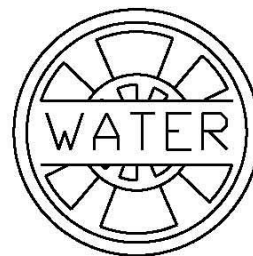
RESILIENT SEAT GATE VALVE



GATE VALVE SECTION
(CLOSED)



VALVE AND BOX INSTALLED



VALVE BOX LID
CAST IRON, 2 PIECE, SCREW TYPE



TULLAHOMA UTILITIES BOARD

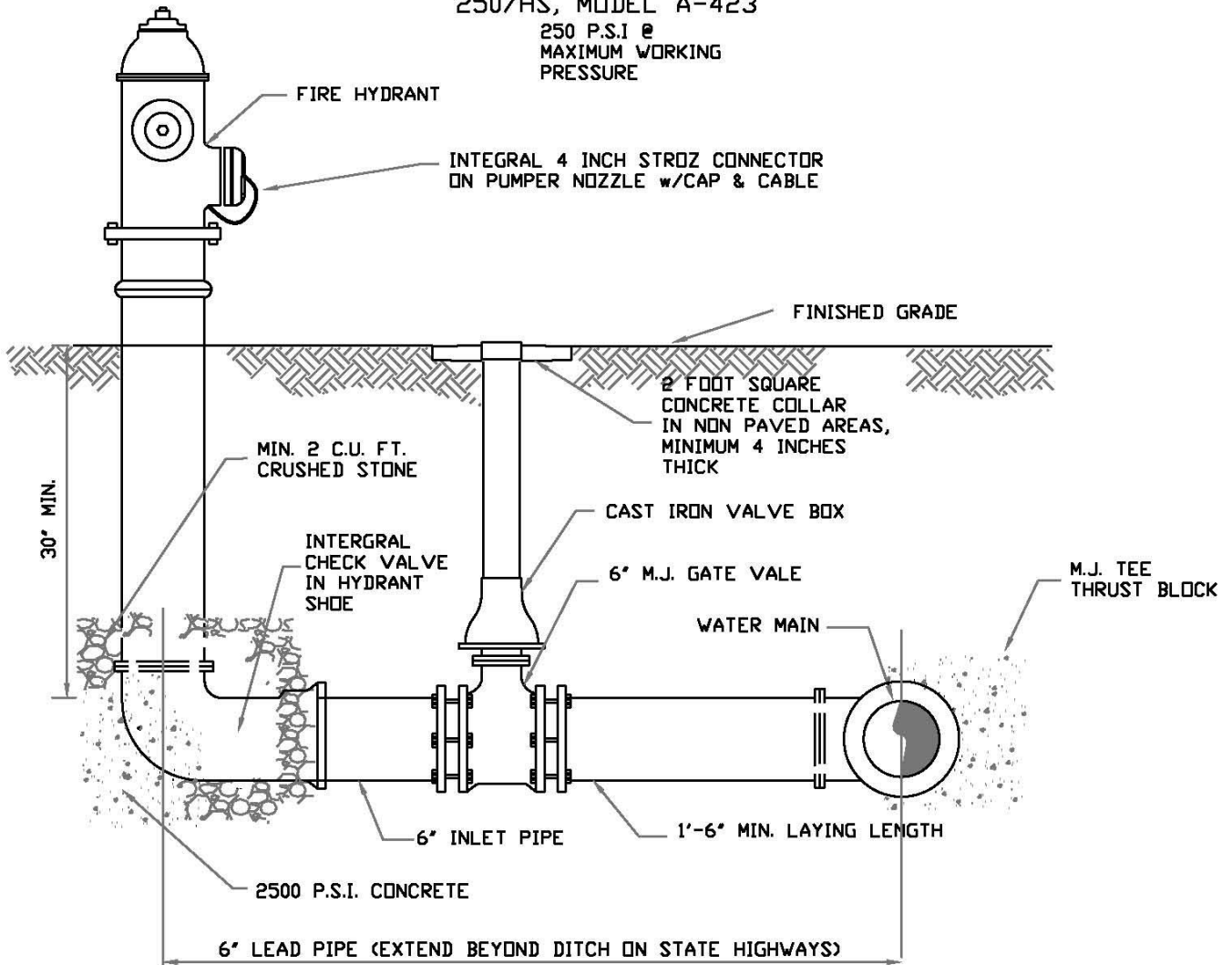
GATE VALVE AND VALVE BOX GV-VB1

DRAWN BY: M.K.E..

DATE: 11-12-2009

NOT TO SCALE

MUELLER® SUPER CENTURION
 250/HS, MODEL A-423
 250 P.S.I @
 MAXIMUM WORKING
 PRESSURE



TYPICAL FIRE HYDRANT INSTALLATION



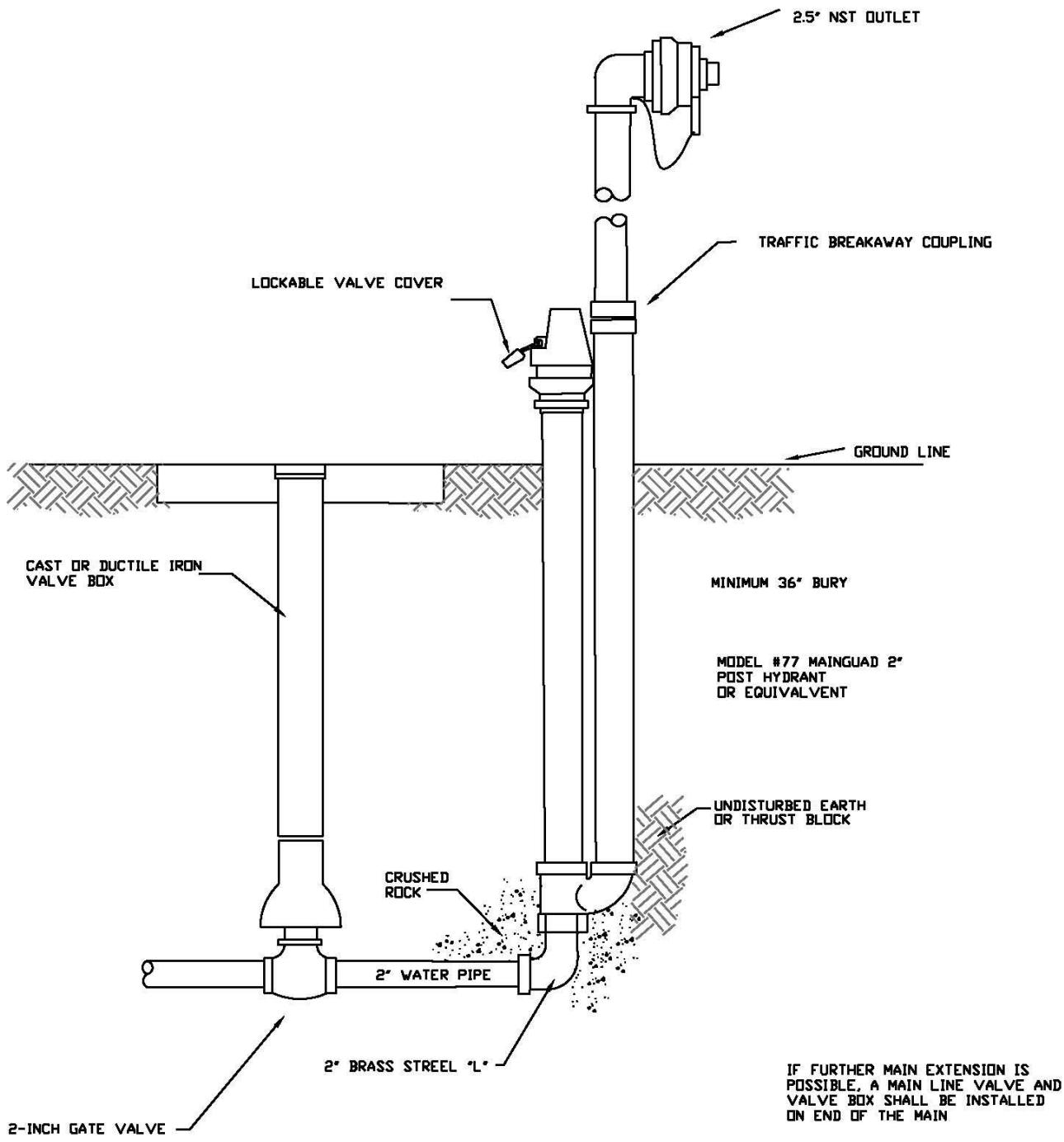
TULLAHOMA UTILITIES BOARD

FIRE HYDRANT ASSEMBLY FHA1


DRAWN BY: M.K.E..

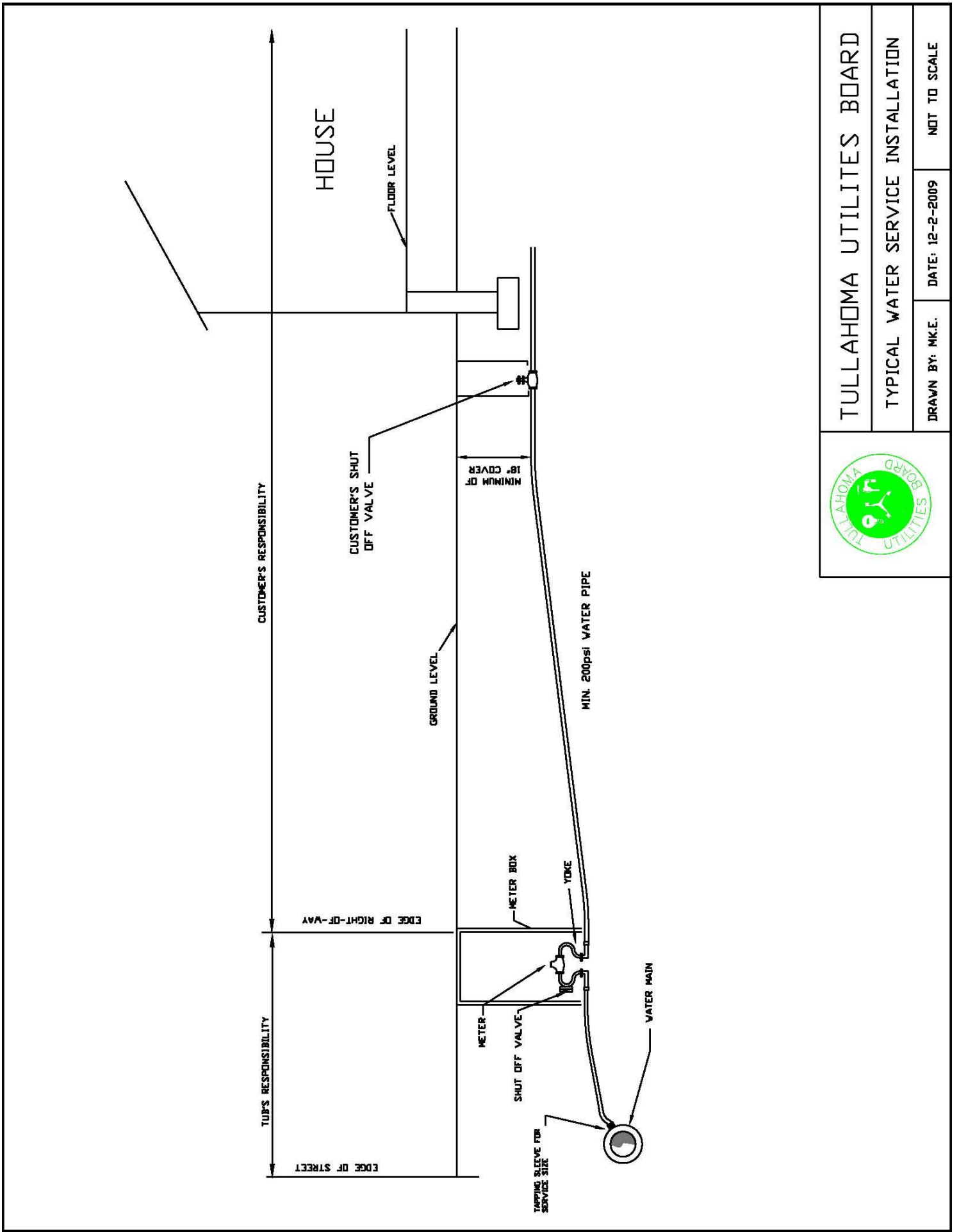
DATE: 10-20-2009

NOT TO SCALE

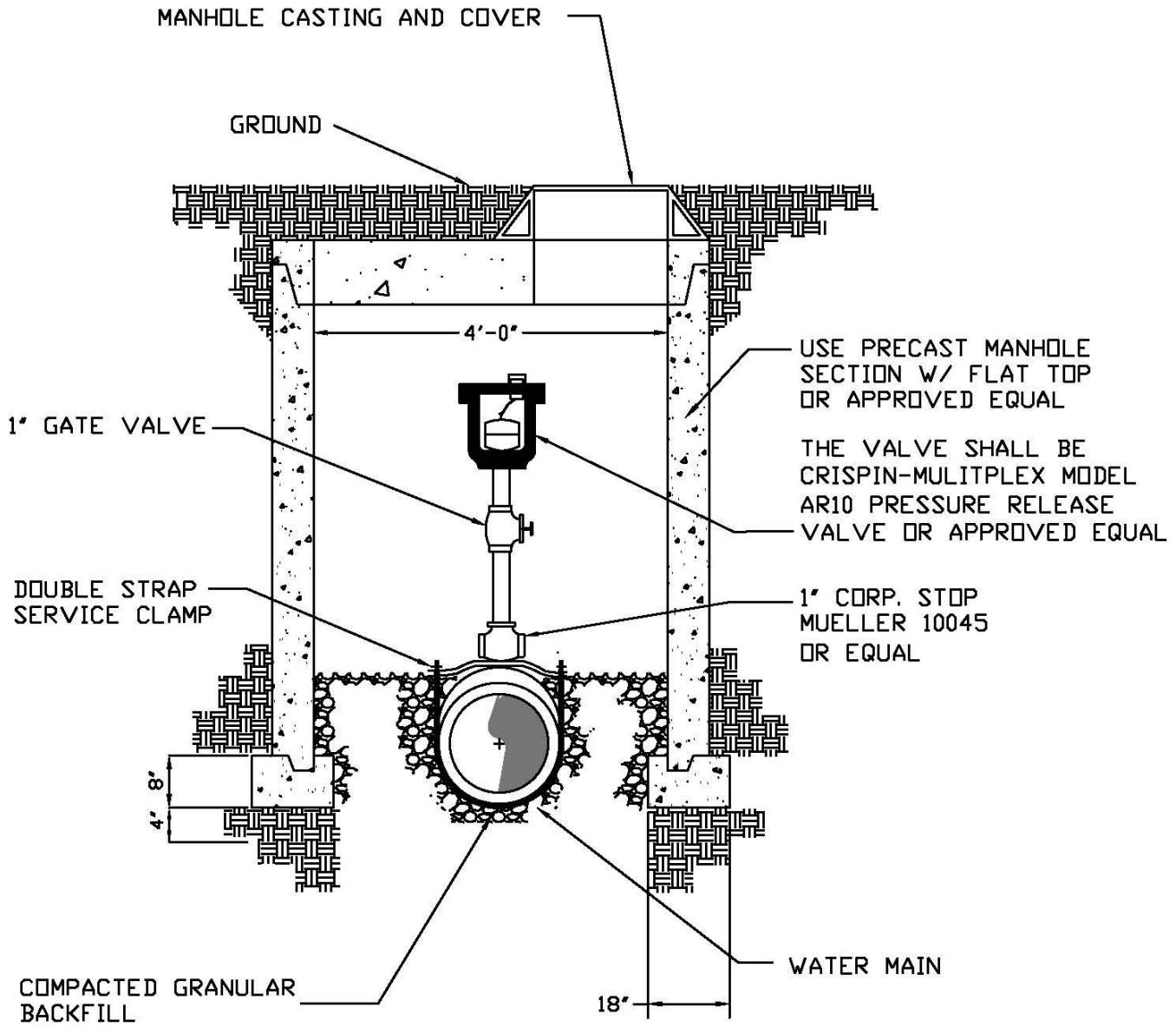


BLOWOFF HYDRANT ASSEMBLY

	TULLAHOMA UTILITIES BOARD	
	END-OF-LINE BLOWOFF ASSEMBLY	
	DRAWN BY: M.K.E..	DATE: 10-30-2009
NOT TO SCALE		




TULLAHOMA UTILITES BOARD
 TYPICAL WATER SERVICE INSTALLATION
 DRAWN BY: M.K.E. DATE: 12-2-2009 NOT TO SCALE



AIR RELEASE VALVE ASSEMBLY

NOTE: 1" VALVE REQ'D. ON 8" AND SMALLER WATER MAIN, AND
2" VALVE REQ'D. ON 10" AND LARGER WATER MAINS.

	TULLAHOMA UTILITIES BOARD	
	AIR RELEASE VALVE ASSEMBLY AR-VA1	
	DRAWN BY: M.K.E..	DATE: 02-16-2010
NOT TO SCALE		

ACTUAL PLACEMENT OF METER VAULT SHALL BE DETERMINED TO PROVIDE POSITIVE DRAINAGE FROM BOTTOM OF VAULT

4" PVC DRAIN PIPE
SLOPE AT MIN. 1.00%

MINIMUM DISTANCE 5 TIMES NOMINAL METER DIAMETER OR AS SPECIFIED BY MANUFACTURER

90° BEND TYPICAL

D.I.P. BY-PASS LINE

GATE VALVE W/ VALVE BOX TYPICAL

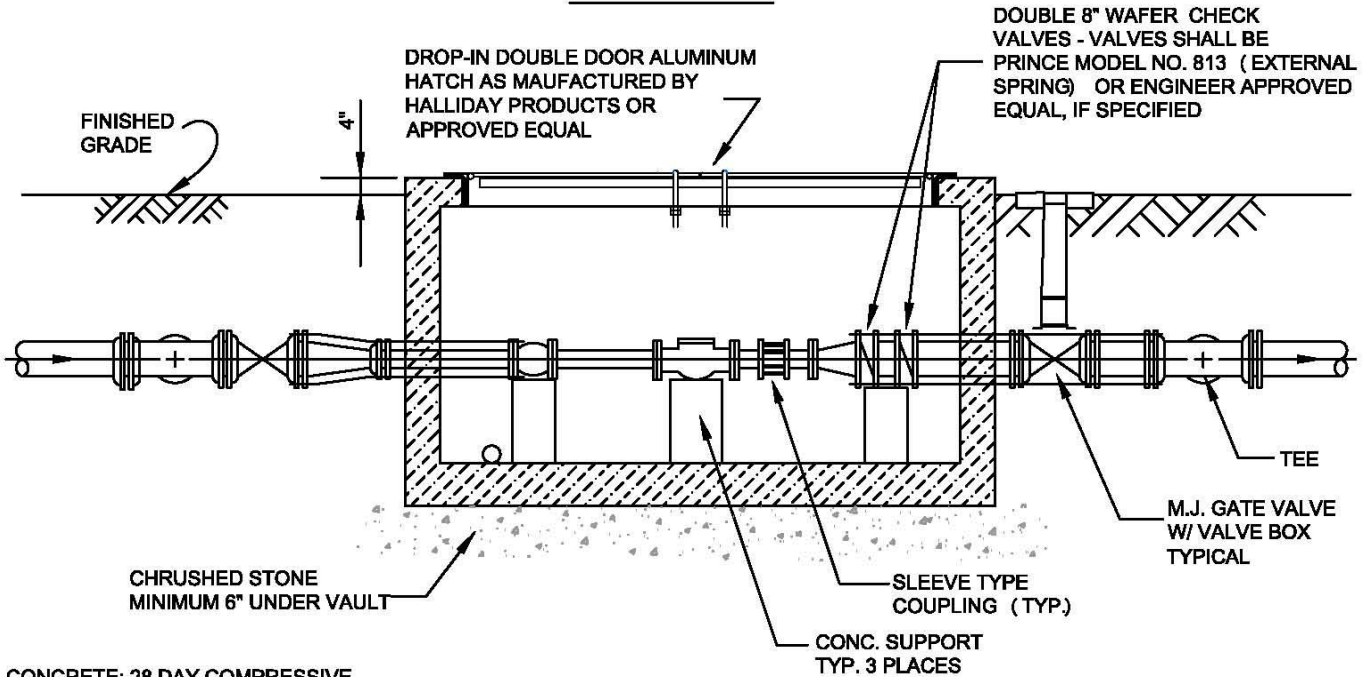
TEE TYPICAL

CONCRETE THRUST BLOCKING TYP.

STRAINER IF NOT INTEGRAL TO METER

METER SHALL BE A SENSUS OMNI C2 TO BE COMPATIBLE W/ TUB AMI SYSTEM. AMI INTERFACE UNIT TO BE PURCHASED FROM TUB AT COST

PLAN VIEW



ELEVATION

CONCRETE: 28 DAY COMPRESSIVE STRENGTH = 4,500 PSI.

REINFORCING: ASTM A-615, GRADE 60.

JOINT SEALANT: BUTYL RUBBER SS-S-00210

METER TO BE INSTALLED A MAXIMUM DEPTH OF 3' 0"



TULLAHOMA UTILITIES BOARD

LARGE WATER METER DETAIL MV1

DRAWN BY: F.D.W.

DATE: 11/01/2012

NOT TO SCALE